Space Weather Technical Forecast

Issued on Friday, 19 May 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 Likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with X-ray activity recorded at GOES16 with occasional M-class flares, these originating from AR3311. The most significant flare was a long duration M-class flare from AR3311 peaking at M3.8 at 18/2023 UTC. AR3311 is one of eight numbered sunspot regions on the visible disc. It appears to be the most complex, with a Dac/beta-gamma configuration. However, AR3310 is the largest region on the disc and may contain a delta spot, but is still close to the eastern limb and therefore hard to analyse. AR3310 is currently classified as Hkx/alpha. AR3305 (Dai/beta) may develop a small and weak delta spot if penumbra continues to increase and consolidate within intermediate spots. The remaining spots are relatively stable, small and weak.

There are currently many filaments on the disc. There have been various filament eruptions over the past 24 hours, and also prominence eruptions, these mainly from the NE limb or quadrant or far sided. At present none of the associated CME's are expected to be Earth directed, although confirmation is awaited following the results of modelling.

However, an earlier filament eruption from the southwest quadrant, around 17/1800 UTC, appears to have an Earth directed component.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR and ACE at L1, has continued at background levels, generally around 350 km/s. The solar wind density remained in single figures ppcc. The IMF was weak, at 4nT or below, while the north-south component was also weak and often positive. The phi angle was positive (away from the Sun) throughout.

The net result of the above solar wind measures was for Quiet (Kp 0-1) geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as measured at GOES16 showed a continued slow decline in the wake of 16 May's M9.6 from AR3310, having peaked at 0.8pfu - i.e. roughly a decade below S1.
High energy electron flux (greater than 2MeV), as measured at GOES16 was at Normal Background levels. The 24-hour integrated fluence has been well below Active levels. At 19/0001UTC, 2.36e6 integrated pfu was recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate, with a Slight Chance of X-class. No significant regions leave the disc in the period, and no new large regions are expected to arrive, leading to a level risk throughout.

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Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: A filament eruption on the 17th from the southwest quadrant resulted in a CME, which has now been analysed with a potential Earth directed component arriving on the 21st. However, this CME is likely to be weak, and a significant impact is unlikely.

A high speed stream (HSS) from CH03 is expected to arrive tomorrow at Earth, most likely in the evening, with speeds of 450-500 km/s expected. The effects of the HSS are likely to wane through day 4 (22nd).

Therefore Quiet (Kp 0-1) geomagnetic activity is expected until tomorrow, increasing to become Quiet to Unsettled (Kp 2-3) later tomorrow, with Active (Kp 4) intervals likely with the onset of the HSS tomorrow and also with the excepted CME arrival on day 3 (21st) and then residual CME effects lasting into early day 4 (22nd). By late day 4 generally Quiet (Kp 0-2) conditions are expected to return.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux carries a daily Slight Chance of S1, largely as a result of the eastern hemisphere spots, with this very gradually rising over the four days.

High energy electron flux (greater than 2MeV) should most likely remain at Normal Background levels, although with an increasing trend later in the forecast period due to the HSS arrival. Active fluence is not expected.

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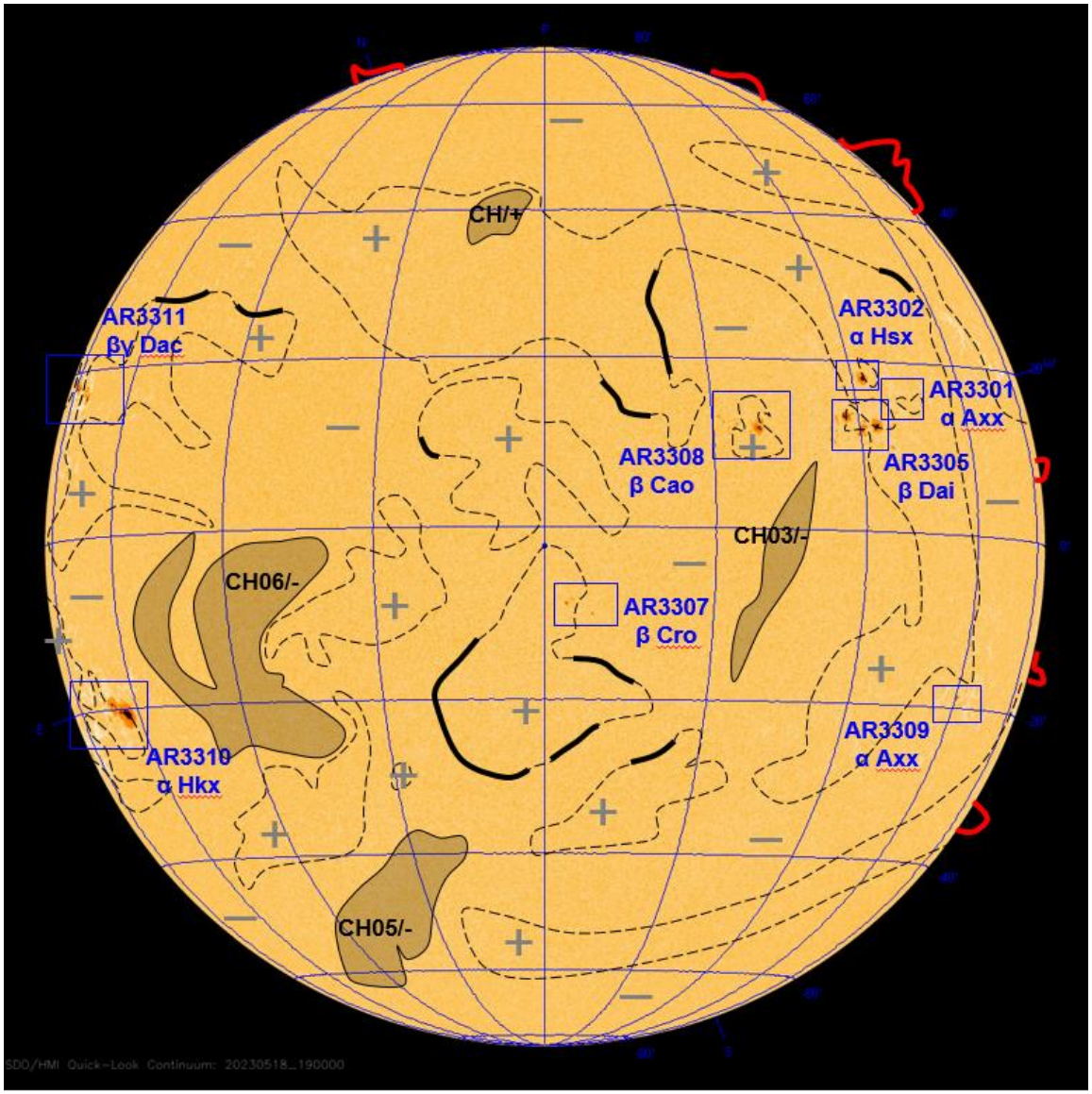
Figure 1. Solar Analysis Valid 18/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption on the 17th from the southwest quadrant resulted in a CME, which has now been analysed with a potential Earth directed component arriving on the 21st. However, this CME is likely to be weak, and a significant impact is unlikely. Other various CME's. from prominence eruptions, filament eruptions and far sided events, are not expected to be Earth directed, although the results of modelling are awaited.

The sole fast wind expected in this forecast period is from CH03/-, with winds likely to be 450-500 km/s. MOSWOC Enlil modelling suggests an onset today. However, this is considered too early by 18-24 hours, with an onset more likely later tomorrow. In addition, the next HSS from CH06 is expected to arrive outside of the forecast period, with Enlil again too fast for this arrival. Quiet (Kp 0-1) geomagnetic activity is expected until tomorrow, increasing to become Quiet to Unsettled (Kp 2-3) later tomorrow, with Active (Kp 4) intervals likely with the onset of the HSS tomorrow and also with the excepted CME arrival on day 3 (21st) and then residual CME effects lasting into early day 4 (22nd). By late day 4 generally Quiet (Kp 0-2) conditions are expected to return.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
18/0316	Partial	Filament eruption	SW	406	21/0900-1200	Low confidence. Limited shock.

Figure 2: MOSWOC Enlil ensemble runs.

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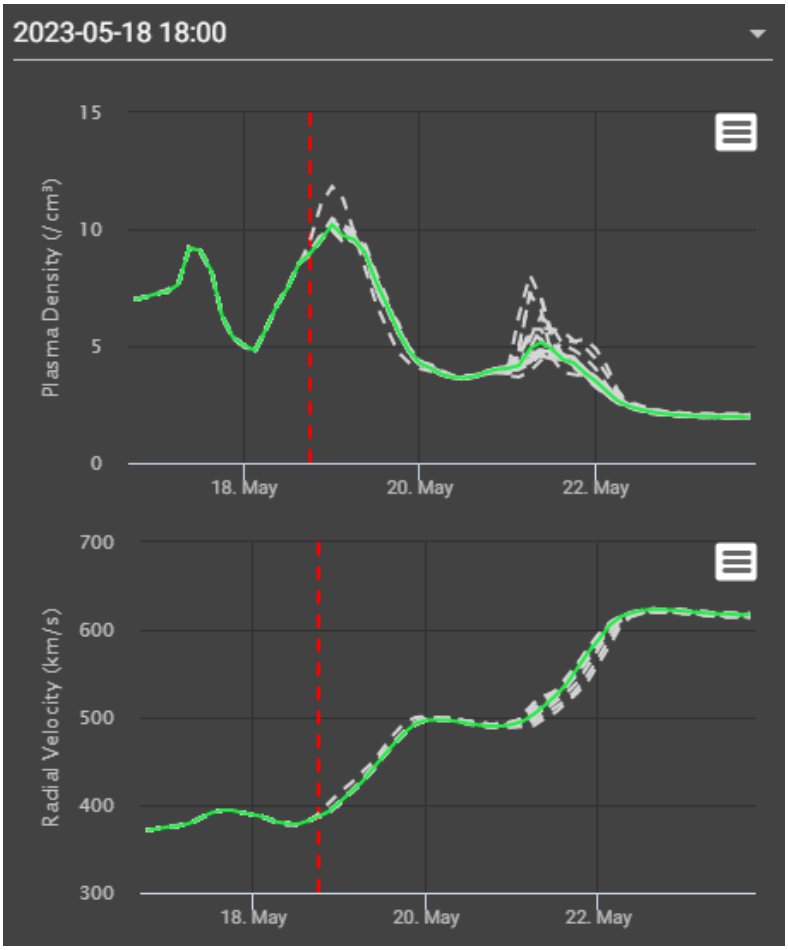

Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc, including the recently numbered AR3311 near the northeast limb. This is possibly the most complex region, as it appears to have a beta-gamma configuration. AR3310 remains the largest region on the disc, but is still close to the east limb and so hard to analyse. However, the trailing spots and penumbra appear to have consolidated with the leader spot, resulting with the current classification of Hhx. As the region becomes clearer, as it rotates westwards, there is potential for delta spots to become visible. AR3305 is now classified as a Dai, and has continued to increase in size with a slight growth in penumbra on some intermediate spots. This has resulted in the region becoming very close to developing a small delta spot.

Solar activity is likely to be Moderate, with a Slight Chance of X-class, with AR3310 and AR3311 the most likely sources of these flares. No significant regions leave the disc in the period, and no new large regions are expected to arrive, leading to a level risk throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	15	15	15	15

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16 is now gradually relaxing back towards Background levels, having become slightly enhanced in the wake of the M9.6 flare from 16 May.

AR3310 and AR3311 are the most likely source for any further enhancements, and to a lesser extent AR3305. As AR3310 and AR3311 transit further across the visible disc so the risk of high energy proton events increases slightly through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has remained at normal Background levels over the past 24 hours.

There is only one source of fast wind possible in the four-day period, the minor coronal hole doublet of CH03/-. This is a persistent feature, but its influence during the past rotation was entirely masked by a CME-derived G4. MOSWOC Enlil's current thoughts of a gradual rise to 450-500km/s is accepted, but not until tomorrow, with low confidence. Therefore high energy electron flux is expected to rise as result of the HSS from CH03, but not until later in the period, reaching moderate levels.

The associated fluence is expected to remain below the Active (1e8 integrated flux) level throughout, but with an increasing trend likely late in the period, as indicated by the Met Office REFM model.

GEO Electron Environment	Level (cm^{-2} sr^{-1}	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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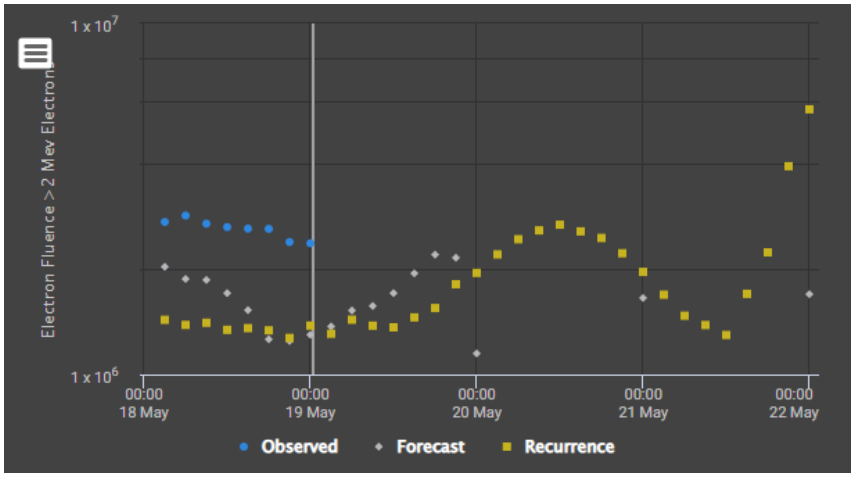
Probability (Exceedance)	day^{-1})	(Yes/No)	(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ 1x10^{8}**	No	1	1	10	20
Very Active	**≥ 2 MeV ≥ 1x10^{9}**	No	1	1	1	1

Figure 3: MOSWOC REFM model.



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